The Patent Office

INVESTOR IN PEOPLE

The Patent Office
Concept House
Cardiff Road
Newport
South Wales
NP10 8QQ

REC'D 20 MAR 2003
WIPO PCT

PRIORITY DOCUMENT

SUBMITTED OR TRANSMITTED IN COMPLIANCE WITH RULE 17.1(a) OR (b)

I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

I also certify that the attached copy of the request for grant of a Patent (Form 1/77) bears an amendment, effected by this office, following a request by the applicant and agreed to by the Comptroller-General.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., plc, P.L.C. or PLC.

Re-registration under the Companies Act does not constitute a new legal entity but merely subjects the company to certain additional company law rules.

Signed R. Mahoney

Dated 3 March 2003

BEST AVAILABLE COPY

@001

Patents Form 1/77

Patents Act 1977
(Rule 16)

The Patent Office

17JAN02 E688685-1 C47904
P01/7700 0.00-0201018.9

THE PATENT OFFICE
17 JAN 2002
RECEIVED BY FAX

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

The Patent Office
Cardiff Road
Newport
Gwent NP9 1RH

1. Your reference

X429a

2. Patent application number
(The Patent Office will fill in this part)

0201018.9 17 JAN 2002

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

Xaar Technology Limited
Science Park
Milton Road
Cambridge
CB4 0XR

Patents ADP number *(if you know it)*

7301872002

If the applicant is a corporate body, give the country/state of its incorporation

UK

4. Title of the invention

Droplet Deposition Apparatus

5. Name of your agent *(if you have one)*

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

~~Nick Roberts~~
~~Xaar Technology Limited~~
~~Science Park~~
~~Milton Road~~
~~Cambridge~~
~~CB4 0XR~~

Peter Douglas Garratt
Mathys + Squire
100 Grays Inn Rd
London
WC1X 8AL

51/77
30/4/2
pm

Patents ADP number *(if you know it)*

1081001

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*
—		

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*
—	

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*
a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body.
See note (d))

YES

0026495 17-Jan-02 04:03

Patents Form 1/77

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	
Description	16
Claim(s)	8
Abstract	—
Drawing(s)	10

10. If you are also filing any of the following, state how many against each item.

Priority documents	—
Translations of priority documents	—
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	—
Request for preliminary examination and search *(Patents Form 9/77)*	—
Request for substantive examination *(Patents Form 10/77)*	—
Any other documents *(please specify)*	—

11. I/We request the grant of a patent on the basis of this application.

Signature Nick Robts Date 1/1/02

12. Name and daytime telephone number of person to contact in the United Kingdom — Nick Roberts (01223) 423663

Warning

After an application for a patent has been filed, the Comptroller of the Patent Office will consider whether publication or communication of the invention should be prohibited or restricted under Section 22 of the Patents Act 1977. You will be informed if it is necessary to prohibit or restrict your invention in this way. Furthermore, if you live in the United Kingdom, Section 23 of the Patents Act 1977 stops you from applying for a patent abroad without first getting written permission from the Patent Office unless an application has been filed at least 6 weeks beforehand in the United Kingdom for a patent for the same invention and either no direction prohibiting publication or communication has been given, or any such direction has been revoked.

Notes

a) If you need help to fill in this form or you have any questions, please contact the Patent Office on 0645 500505.

b) Write your answers in capital letters using black ink or you may type them.

c) If there is not enough space for all the relevant details on any part of this form, please continue on a separate sheet of paper and write "see continuation sheet" in the relevant part(s). Any continuation sheet should be attached to this form.

d) If you have answered 'Yes' Patents Form 7/77 will need to be filed.

e) Once you have filled in the form you must remember to sign and date it.

f) For details of the fee and ways to pay please contact the Patent Office.

0026495 17-Jan-02 04:03

Droplet Deposition Apparatus

The present invention relates to droplet deposition apparatus, their methods of manufacture and methods of operation and printers containing such apparatus.

The versatility of inkjet printheads have made them suitable for a number of today's markets and recently significant gains have been made in markets typically dominated by other printing techniques such as laser printers and screen printers.

Laser printers are still dominant in the high-end office market where they are capable of printing about 4-10 colour pages per minute and 20 – 30 pages per minute black. Inkjet printers are already on sale that can print at a speed approaching 10 pages per minute colour and pagewide array printheads are in development that are capable of printing 100 pages a minute full colour.

The present invention seeks to provide improved apparatus, methods and routines that address this situation and problems.

Accordingly, the present invention consists in one aspect of a drop on demand printhead module comprising a substrate, a plurality of arrays of actuator elements, each array comprising a row of ejection chambers extending across said substrate, wherein said arrays are arranged in a direction perpendicular to that of said rows, a barrier provided to between adjacent arrays such that adjacent arrays are located in separate manifold chambers, two ink communication ports with openings located within said manifold chambers wherein an array is positioned between said communication ports.

If the module is of a particular size it may be beneficial to locate two or more ink communication ports within said manifold chambers. It is desirable that similar numbers of these ports are situated on either side of the array to ensure an

even ink flow.

A cover, which is preferably separate to the barriers extends over the manifold chambers and the arrays. Ejection nozzles can be formed in a separate nozzle plate bonded to the cover which contains ejection ports communicating between the ejection chambers and the nozzles.

Preferably the ink communication ports are formed in the substrate, however it is also possible to provide ejection ports in the substrate and supply the ink to the manifold chambers from the cover.

This construction is appropriate to most inkjet ejection mechanisms including, but not exclusively, bubblejet, piezoelectric, electrostatic or bimorphs. A particularly preferred ejector is a shear mode piezoelectric device as described in EP 0 277 703

A layer of a polymeric material, such as parylene can be located on the surface of said module to provide protective aspects and additionally performance improvements.

Problems still remain, where more than two arrays of ejector elements are provided, of achieving electrical connection to the inner arrays. Therefore, in another aspect of the present invention there is provided a drop on demand printhead module comprising a substrate,a plurality of arrays of actuator elements, each array comprising a row of ejection chambers extending across said substrate, wherein said arrays are arranged in a direction perpendicular to that of said rows, wherein tracks are provided to electrically connect to an array from connectors situated along one edge of the substrate, wherein said tracks extend around the end edges of an array positioned nearer to said edge of said substrate.

The connectors extending along the edge also provide connection to the array closest to the edge. They should be appropriate in robustness and strength to provide electrical and mechanical connection to an external circuit containing driver chips.

Where four rows are provided it is desirable to electrically connect two rows to connectors at one edge of the substrate and two rows to connectors at the opposite edge of the substrate.

The tracks can be formed by any appropriate technique but preferably by an electroless method and the tracks being defined by laser patterning.

The substrate must be of a suitable arrangement and thus there is provided a substrate for a drop on demand printhead module having a width and supporting a plurality of rows of ejection chambers and connecting tracks, said rows of ejection chambers extending in the width direction the rows being arranged in parallel and at an increasing distance from an edge, said tracks connecting said plurality of rows of ejection chambers to an array of connection points along said edge of said substrate, the width of said substrate being such that tracks pass past the end of the row of ejection chambers closest to said edge.

Since the modules preferably have ink continually flowing through the ejector chambers it is necessary to provide at least two times the number of supply ports to get the ink in and out of the module. This could lead to a very complex device especially considering that four or more colours also need to be supplied to the printhead.

According to a further aspect of the present invention, there is provided an ink supply for an inkjet printhead module comprising a support having a top surface and a bottom surface, a printhead mounted to said top surface, a plurality of

walls extending from said bottom surface to define a plurality of partitioned rooms, and an insert provided between said partitions, said insert defining at least one chamber.

The insert can define the chamber completely or just provide a further partition within the rooms. Ports are provided in the inserts that align with holes in the module substrate and holes provided in the top of the support

Alternatively, the plastic inserts 28, preferably containing supply fittings 34 are provided and laminated with partitions 32, the partitions being distinct and unconneced by a top plate. The top surface 36 onto which the module is mounted can be machined or lapped to form a flat surface. Other features may be moulded into the insert such as alignment features.

The insert is preferably plastic and coated with a layer of parylene, said layer of parylene extending through the holes provided in the top of the support to provide a seal. The parylene also traps dirt and prevents shedding of fibres from the plastic material and additionally prevents corrosive attack from certain types of ink.

The ink flow within the support should be arranged so that the very two outer chambers contain ink flowing from a printhead. These two chambers are adjacent the driver chip and thus quickly remove heat. Temperature differences to the ink inlets of each colour may have a detrimental effect on the print quality and thus it is desirable to place the chambers containing the inlet of neighbouring arrays adjacent each other.

Thus, there is provided a method of supplying ink to a plurality of R rows of ejection chambers mounted onto an ink supply support comprising the steps, providing an ink supply support having 2R chambers arranged across the width of the support, dividing the 2R chambers into equal numbers of inlet chambers

and outlet chambers, causing ink to flow from an inlet chamber to an outlet chamber via an ejection chamber in one of said R rows of ejection chambers wherein the flow directions through ejection chambers in neighbouring rows are opposite.

A printhead is provided comprising a support and a plurality of modules of arrays of actuators mounted thereto, said modules being arranged linearly and adjacently, said arrays being arranged linearly but not adjacently.

A method of printing said printhead is also provided comprising the steps

a) printing a first swath from said arrays

b) indexing said printhead a distance equal to 1/n of a swath width plus 1/n of a nozzle pitch,

c) repeating steps a and b 2n times where n is an integer greater than 1

The invention will now be described, by way of example only, with respect to the following drawings in which:

Figure 1 is an exploded view of a printhead module according to the present invention,

Figure 2 depicts a supply support

Figure 3 shows the direction of ink flow within said support and printhead module

Figure 4 is a wide printhead formed of a plurality of like modules

Figure 5 depicts the colour configuration of said modules – C, cyan, M, magenta, Y, yellow, K, black

Figure 6 depicts the printhead arrangement for a single pass printhead

Figure 7 depicts a printer configuration

Figure 8 depicts the printing routine

With respect to Figure 1, a substrate 1 is provided with four arrays 2a to 2d of

piezoelectric material interspaced at an appropriate distance (d).

The substrate is formed of a material having thermal expansion characteristics similar to the piezoelectric material used elsewhere in the printhead and must be robust enough to withstand the various manufacturing processes. Aluminium nitride, Alumina, INVAR or special glass AF45 are all examples of suitable candidate material.

Ports 4a to 4 are formed through the substrate at positions that fall within the inter-array spacing d. It is preferable that in manufacture the ports are formed prior to attaching the piezoelectric material 2a to 2d forming the arrays though it is of course possible to drill them afterwards. Any suitable hole forming process is acceptable including ablation, drilling, etching etc.

In operation, the module will operate as a four colour, through flow printhead and thus it is necessary to provide two separate ports for each array which are located on either side of each array. A barrier 8 is provided that dissects the ports for adjacent rows in order to prevent colour mixing.

In manufacture strips of piezoelectric material are bonded to the substrate 1 and subsequently cut to form channels or ejection chambers. A continuous layer of conductive material is deposited over the strips and parts of the substrate and electrodes and conductive tracks defined thereon. Beneficially the sides of the strips are chamfered to aid laser patterning.

A continuous layer of conductive material is then applied over the channel walls and substrate. Not only does this form electrodes for application of electric fields to the piezoelectric walls and the conductive tracks on the substrate for supply of voltages to those electrodes, it also forms an electrical connection between those two elements.

Appropriate electrode materials and deposition methods are well-known in the art. Copper, Nickel and Gold, used alone or in combination and deposited advantageously by electroless processes utilising palladium catalyst will provide the necessary intergity, adhesion to the piezoelectric material, resistance to corrosion and basis for subsequent passivation e.g. using Silicon Nitride as known in the art.

As is generally known, e.g. from EP-A-0 364 136, the electrodes on opposite sides of each actuator wall must be electrically isolated from one another in order that an electric field may be established between them and hence across the piezoelectric material of the actuator wall. The corresponding conductive tracks connecting each electrode with a respective voltage source must be similarly isolated.

In the present invention, such isolation may be achieved at the time of deposition for example by masking those areas - such as the tops of the channel walls - where conductive material is not required. Suitable masking techniques, including patterned screens and photolithographically patterned masking materials are well-known in the art, e.g. from WO 98/17477 and EP-A-0 397 441, and will not be described in any further detail.

Alternatively, isolation may be achieved after deposition by removing conductive material from those areas where it is not required. Localised vaporisation of material by laser beam, as known e.g. from JP-A-09 010 983, has proved most suitable for achieving the high accuracy required, although other conventional removal methods - inter alia sand blasting, etching, electropolishing and wire erosion may also be suitable. Material removal can be used to remove material from the entire top surface of the wall so as to maximise the wall top area available for bonding with the cover member or from a narrow band running over the top of the wall.

In addition to removing conductive material from the top surface of each piezoelectric actuator wall so as to separate the electrodes on either side of each wall, conductive material must also be removed from the surface of the substrate in such a way as to define respective conductive tracks for each electrode.

It will also be appreciated that the electrodes and conductive tracks associated with the active portions need to be isolated in order that the rows of nozzles might be operated independently. Although this too may be achieved by a laser "cut" along the surface of the substrate extending between the two piezoelectric strips, it is more simply achieved by the use of a physical mask during the electrode deposition process or by the use of electric discharge machining.

The conductive tracks defined by laser may extend all the way from the transition area to the integrated circuits located at either side of the substrate. Alternatively, the laser track definition process may be restricted to an area directly adjacent the piezoelectric material and a different - e.g. photolithographic - process used to define further conductive tracks that connect the laser-defined tracks with the integrated circuits.

Thereafter, both electrodes and tracks will require passivation, e.g. using Silicon Nitride deposited in accordance with W0 95/07820. Not only does this provide protection against corrosion due to the combined effects of electric fields and the ink (it will be appreciated that all conductive material contained within the area defined by the inner profile of spacer member will be exposed to ink), it also prevents the electrodes on the opposite sides of each wall being short circuited by the planar cover member. Both cover and spacer are advantageously made of molybdenum or NILO 42 which, in addition to having similar thermal expansion characteristics to the alumina used elsewhere in the printhead, can be easily machined, e.g. by etching, laser cutting or punching, to

high accuracy.

The substrate is sized and arranged such that the electric tracks to the inner strips of piezoelectric material originate from points adjacent to two opposed edges of the substrate and follow a route around the ends of the outer strips of piezoelectric material. Typical originating points are bond pads or stud bumps and the like.

Beneficially this allows for all four strips of piezoelectric material to be operated via two flexible circuits connected to the originating points without resorting to complex multi-layer wiring. Both the substrate and rows of piezoelectric material and the flexible circuits may be individually tested prior to combining in order to increase overall yield.

The spacer member comprises four inner cavities corresponding to the four strips of piezoelectric material. The inner profiles of each of these cavities are such that bubble traps are avoided. Bubble traps are further avoided by positioning the trough of the profile such that it aligns with or even overlies the edge of the respective ink port. Whilst only a single ink port is shown, a number of ink ports may be provided per cavity and in this case a wavy inner profile is preferred with an ink port located within each trough. The crest of the wavy profile is similarly dimensioned (to lie a distance - typically 3mm, approximately 1.5 times the width of each strip - from the edge of the adjacent strip to ensure avoidance of bubble traps without affecting the ink flow into the channels.

Spacer member is subsequently secured to the upper surface of substrate by a layer of adhesive. In addition to its primary, securing function, this layer also provides back-up electrical isolation between the conductive tracks on the substrate. Registration features such as a notch are used to ensure correct alignment.

The last two members to be adhesively attached - either separately or following assembly to one another - are the planar cover member and nozzle plate. Optical means may be employed to ensure correct registration between the nozzles formed in the nozzle plate and the channels themselves. Alternatively, the nozzles can be formed once the nozzle plate is in situ as known, for example, from W0 93/15911.

One additional manufacturing stage which may be performed either before or after forming the nozzles, but preferably before, is applying a conformal coating of parylene to the actuator. The coating is applied in the vapour phase and allowed to diffuse over and through the printhead module. One advantage of parylene found by the applicant is that the size of the ports through which it diffuses have a limiting effect on the speed at which it is deposited and correspondingly the thickness of the layer formed.

Thus, in a single step it becomes possible to passivate the actuator channels with a thin coating of passivant and the ink supply manifolds and ports with a thicker coating of passivant.

Beneficially, any particles of dirt or manufacturing debris remaining within the printhead can be bound to the walls minimising the chance of nozzle blockage occuring once the head is filled with ink.

Once the module has been found to be working it can be bonded to the ink supplying support. Preferably at this point parylene can be allowed to diffuse through the entire printhead structure as shown in figure 6. Beneficially the parylene can be used to seal any ink leaks within the system. Whilst parylene can diffuse through the system passively sometimes it is beneficial to force it through the system which is made possible by using the fact that ink can flow continually through the chamber.

The benefits of a through flow ink supply and particularly where the ink flows continually through the ejection chambers even when printing is known, e.g. from WO 00/38928.

A cut out of an ink supply according to the present invention is described with respect to Figure 2.

A support 20 is formed either as an extrusion or as a cast module with aluminium or alumina being the preferred materials of manufacture. It is desirable that the material has a thermal expansion similar to that of the printhead module 22 with a relatively high thermal transfer coefficient in order to transfer as much heat as possible from the driver chips 24 to the ink contained within the chambers 30.

The support supplies ink of four different colours to the rows of actuating elements 2a to 2d and thus four channels are provided between the partitions 26. In order to provide both an inlet and outlet manifold to supply and remove the circulating ink, a plastic insert 28 is positioned between the partitions.

The insert defines two chambers either on its own or, as shown in Figure 2, in conjunction with the partitions themselves. This is the preferred embodiment as it allows a good heat transfer from the chip to the ink across a conductive exterior partition whilst minimising heat transfer between an inlet and outlet chamber as they are separated by an insulating plastic partition.

It is preferred, but it is not essential, that the ink flow within the support follows the directions shown in figure 3. Thus, an ink outlet is always adjacent the chips located next to the outer partition and the inlets of neighbouring colours are always adjacent one another. This arrangement helps to minimise heat transfer within the head structure.

Ink is preferably supplied to and from the chambers through a supply port 32 located in the base of the insert rather than from the end of the support. Beneficially this allows for simpler and more elegant connection possibilities in the wider head configuration described below. Any fitting may be possible in the present invention including quick fit and screw type connectors.

Ports formed in the top of the plastic insert align with both ports formed in the top of the support and the ports in the substrate of the actuator element. Beneficially a coating of parylene can be applied to coat the inlet and outlet chambers and ports to provide a fluid tight, leak free seal.

The choice of plastics material forming the insert, whilst important, is widened through use of the construction above. Problems caused by thermal expansion mismatches are reduced by locating the insert within a fairly rigid structure and shedding of particles and ink incompatibilities, particular problems with some kinds of plastics are effectively eliminated by coating the inner surface of the chambers with parylene.

An alternative method of construction and support apparatus will be described with reference to Fugure 3a. The plastic inserts 28, preferably containing supply fittings 34 are provided and laminated with partitions 32. The top surface 36 onto which the module is mounted can be machined or lapped to form a flat surface.

In practice, the modules will be butted together to form an array that is substantially the width of the media to be printed as shown in figure 4. The support of Figure 2, can be scaled to the width of the final array and this raises a number of possible configurations amongst others.

In the first, the complete modules including their supply supports are butted

together to form the increased length array. In the second, the outer support extends the entire width of the array as do the inserts and in the third, the outer support extends the entire width of the array whilst separate inserts are provided for each or a group of the modules.

Where the separate inserts are provided the ease of ink supply is not compromised as all the connection points are located on the opposite face of the printhead to the ejection nozzles. Similarly it is apparent that the electrical connection points are also located remote from the nozzles. This arrangement results in a simple and easily replaceable printhead.

Even where there is a single insert extending the width of the array it may be useful, for pressure drop purposes, to provide a number of inlets and outlets at spaced intervals along the array, the positioning of these being determined by experimentation.

The modules themselves are "I" shaped and this provides a cut-out suitable for confronting with alignment features on the support. These alignment features may be static devices such as dowel pins and the like or active devices such as alignment screws. Other features to aid alignment may be provided on the module itself.

The colour configuration of the array is as shown in figure 5, the colours being arranged at the same position for each of the modules. In the present embodiment, the ejection chambers are arranged at 180dpi in each of the arrays.

In order to provide a continuous array of ejected dots on a substrate it is possible to attach a second printhead, as shown in Figure 6, to the printer mechanism with arrays interleaving the first arrays. This of course adds to the cost of the printer and the array printed can only be at the original 180dpi of the

heads.

A preferred operation of the printer will now be described with respect to Figure 7. The printhead is mounted in a printer comprising a drum onto which paper is loaded. The paper will remain on the drum for a number of turns while the printhead moves above it. The printhead described above has particular suitability to a drum application because of the close spacing between the arrays. Because of the curved surface of the drum, large spacing between the arrays of colour maximise any drop placement errors since the drops from the outer arrays, Cyan and Black, in this situation have further to travel to the media.

The drum may be use a vacuum or other mechanical device to hold the media to the surface. A particularly suitable type of drum is described in WO 99/11551 incorporated herein.

The printing sequence is described with respect to figures 8a to 8d.

Media is loaded onto the drum and held in place by a vacuum system or by grippers, preferably whilst the drum is already rotating at the printing speed. The printhead array, which extends substantially the width of the drum is positioned next to the drum and in a first pass of the paper on the drum all four colours are deposited at, in this case, 180dpi as shown in Figure 8a.

The paper then rotates once, or a plurality of times whilst the whole printhead is moved in the direction of arrow 80. In the simplest configuration, where the spacings between the individual arrays along the printhead are equal to the length of the arrays and printing is required at 180dpi, the printhead can simply be moved the length of one array to fill in the unprinted areas left after the first pass.

If a dot density is required that is twice that of nozzle pitch, the printhead can be

moved in multiples of ½ nozzle pitch. Once moved, a further swath is printed which overlaps with the first printed swath. Because the dots of the two swaths are interleaved the image is now 360dpi.

The array must have moved to a position a distance equal to its length from its starting point before printing the third swath 8c to avoid over-printing the earlier printed dots.

It is a particular feature of the drum system that allows the action of passing media under the paper a plurality of times whilst the head is indexing.

The paper is then removed from the surface of the drum and a new sheet applied. Beneficially the printhead does not have to be immediately moved back to its start position but can be moved in a direction opposite to arrow 80 whilst repeating the printing steps.

By changing the step length to, for example, ¼ of the array length plus ¼ of a drop spacing it is possible to increase the dot spacing still further, in this case, to 720dpi though a larger number of passes are required.

Since the entire head, being made up of a plurality or module, only moves by a distance less than twice the module array lengths the difficulties associated with the acceleration and deceleration of large heads is not observed. This distance is typically below 5 cms. Because the drum rotates at a constant speed accurate drop placement can be realised.

In some cases it may be beneficial to overlap printing from a first array with printing from a second array. Particular examples of these are shown in figure 9 for four and five nozzle arrays of a single colour. Without departing from the scope of the present invention described herein it is possible to operate colour arrays having many more nozzles.

The mathematics behind the routine can be calculated, without invention, by extrapolating the tenets described herein. This applies to arrays arranged at a distance not equal to an array or swath width.

Whilst the above invention has been described with respect to piezoelectric actuators it is equally possible to substitute the invention with other deposition devices including, but not exclusively, bubble jet or other mechanically actuated drop on demand printers.

The invention has been described by way of example only and a wide variety of modifications are possible without departing from the scope of the invention.

Each feature disclosed in this specification (which term includes the claims) and / or shown in the drawings may be incorporated in the invention independently of other disclosed and / or illustrated features.

Claims

1. A drop on demand printhead module comprising a substrate,

a plurality of arrays of actuator elements, each array comprising a row of ejection chambers extending across said substrate, wherein said arrays are arranged in a direction perpendicular to that of said rows

a barrier provided to between adjacent arrays such that adjacent arrays are located in separate manifold chambers,

two ink communication ports with openings located within said manifold chambers

wherein an array is positioned between said communication ports.

2. Apparatus according to Claim 1, wherein two or more ink communication ports are located within said manifold chambers.

3. Apparatus according to Claim 1 or Claim 2, wherein one or more of said ink communication ports are located on one side of said array and one or more of said ink communication ports are located on the opposite side of said array.

4. Apparatus according to Claim 3, wherein a cover extends over said manifold chambers.

5. Apparatus according to Claim 4, wherein said barriers and said cover are

integrally formed.

6. Apparatus according to any preceding claim wherein said ink communication ports are formed in the substrate.

7. Apparatus according to Claim 6, wherein an ejection port through which fluid is ejected is provided in said cover.

8. Apparatus according to any one of Claims 1 to 5 wherein said ink communication ports are formed in the cover

9. Apparatus according to Claim 8, wherein an ejection port through which fluid is ejected is provided in said substrate.

10. Apparatus according to any preceding claim, wherein said ejection chambers eject fluid through the application of thermal energy

11. Apparatus according to any one of Claims 1 to 9 wherein said ejection chambers eject fluid through the application of mechanical energy

12. Apparatus according to Claim 11, wherein said mechanical energy is provided by a piezoelectric material.

13. Apparatus according to Claim 12, wherein said piezoelectric material is PZT

14. Apparatus according to Claim 12 or Claim 13, wherein channels are sawn into said piezoelectric material to form ejection chambers.

15. Apparatus according to Claim 14, wherein electrodes are provided on walls bounding said channels

16. Apparatus according to Claim 15, wherein said channel walls deflect in shear.

17. Apparatus according to any preceding claim wherein tracks are provided on said substrate to apply electrical energy to said arrays.

18. Apparatus according to any preceding claim wherein a coating of a polymeric material is located on the surface of said module

19. Apparatus according to Claim 18, wherein said polymeric material is parylene.

20. A drop on demand printhead module comprising a substrate,

a plurality of arrays of actuator elements, each array comprising a row of ejection chambers extending across said substrate, wherein said arrays are arranged in a direction perpendicular to that of said rows

wherein tracks are provided to electrically connect to an array from connectors

situated along one edge of the substrate, wherein said tracks extend around the end edges of an array positioned nearer to said edge of said substrate.

21. A module according to Claim 20, wherein tracks are provided to connect said connectors to said array positioned nearer to said edge of substrate.

22. A module according to Claim 20 or Claim 21 wherein additional connectors are provided along an opposite edge of said substrate.

23. A module according to Claim 22, wherein tracks are provided to electrically connect said additional connectors situated along said opposite edge of the substrate with an array of actuator elements, wherein said tracks extend around the end edges of an array positioned nearer to said opposite edge of said substrate.

24. A module according to any one of Claims 20 to 23 wherein there is provided four arrays of ejection chambers.

25. A module according to any one of Claims 20 to 24 wherein the tracks are formed by deposition

26. A module according to any one of Claims 20 to 24 wherein the tracks are formed by lift off.

27. A module according to any one of Claims 20 to 24 wherein the tracks are formed by patterning.

28. A module according to any one of Claims 20 to 27 wherein said ejection chambers eject fluid by thermal means.

29. A module according to any one of Claims 20 to 27 wherein said ejection chambers eject fluid by mechanical means.

30. A module according Claims 29, wherein said mechanical means are piezoelectric.

31. A substrate for a drop on demand printhead module having a width and supporting a plurality of rows of ejection chambers and connecting tracks,
said rows of ejection chambers extending in the width direction the rows being arranged in parallel and at an increasing distance from an edge,
said tracks connecting said plurality of rows of ejection chambers to an array of connection points along said edge of said substrate
the width of said substrate being such that tracks pass past the end of the row of ejection chambers closest to said edge.

32. An ink supply for an inkjet printhead module comprising a support having a top surface and a bottom surface,

a printhead mounted to said top surface,

a plurality of walls extending from said bottom surface to define a plurality of partitioned rooms, and

an insert provided between said partitions, said insert defining at least one chamber.

33. A support according to Claim 32, wherein said insert defines said chamber completely.

34. A support according to Claim 33, wherein said insert defines said chamber in conjunction with one or more of said walls.

35. A support according to any one of claim 32 to claim 34, wherein a port is provided that extends through said top surface to fluidically connect to said at least one chamber.

36. A support according to any one of claim 32 to claim 34, wherein said insert is formed from a plastic material.

37. A support according to any one of claim 32 to claim 35 wherein a conformal coating of a monomeric or polymeric material extends over the inner surface of the port and the inner surface of the insert.

38. A support according to Claim 37, wherein said material is parylene

39. A support according to Claim 37 or Claim 38, wherein said material prevents printing defects.

40. A support according to any one of Claim 32 to Claim 39 wherein said chambers contain ink.

41. A support according to Claim 37 to Claim 40, wherein said material prevents leaks.

42. A support according to Claim 32, wherein said partitioned rooms each contain ink of one colour, each colour being different.

43. A method of supplying ink to a plurality of R rows of ejection chambers mounted onto an ink supply support comprising the steps,

providing an ink supply support having 2R chambers arranged across the width of the support,

dividing the 2R chambers into equal numbers of inlet chambers and outlet chambers,

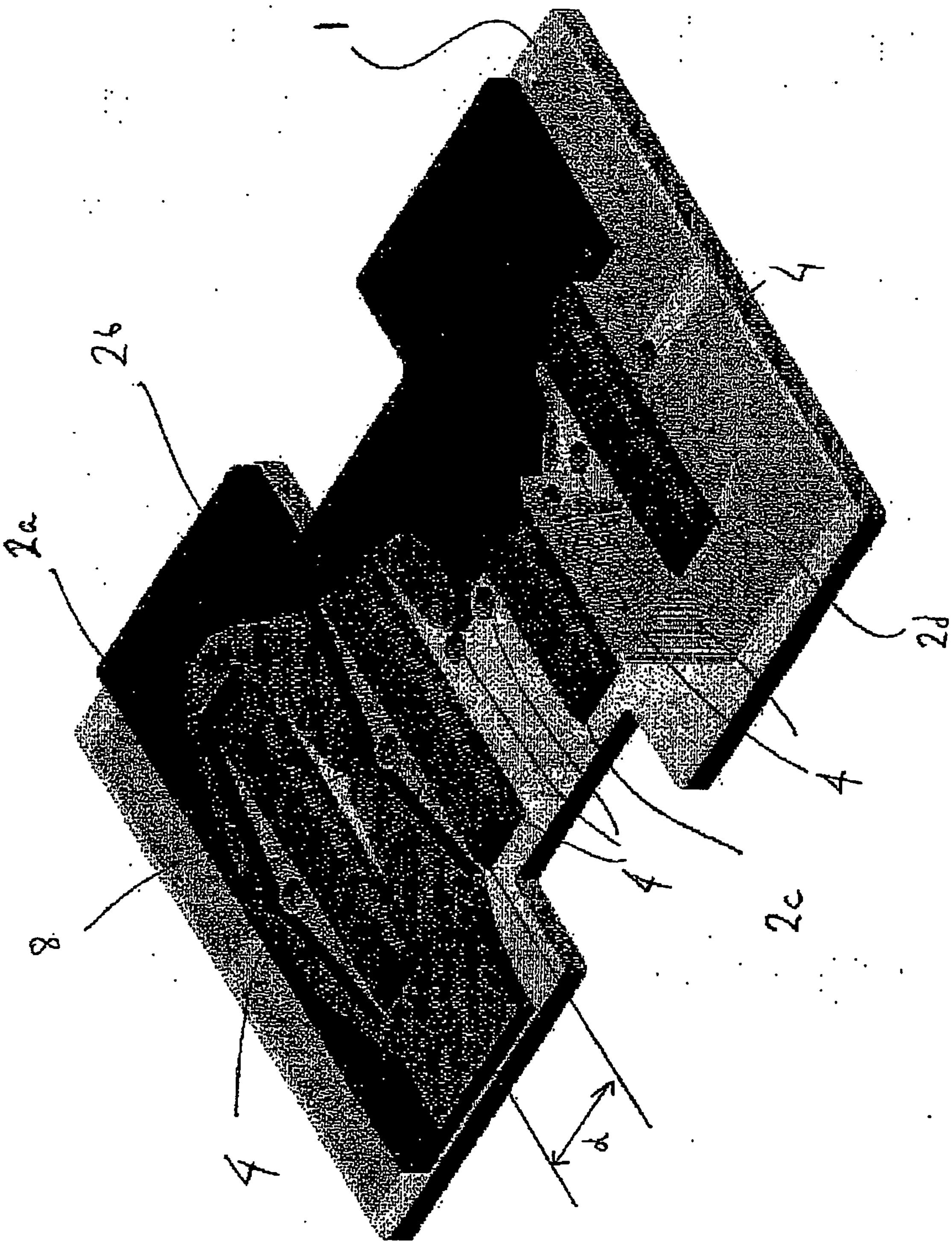
causing ink to flow from an inlet chamber to an outlet chamber via an ejection chamber in one of said R rows of ejection chambers

wherein the flow directions through ejection chambers in neighbouring rows are opposite.

44. A printhead comprising a support and a plurality of modules of arrays of actuators mounted thereto,

said modules being arranged linearly and adjacently,

said arrays being arranged linearly but not adjacently.



Figur 1

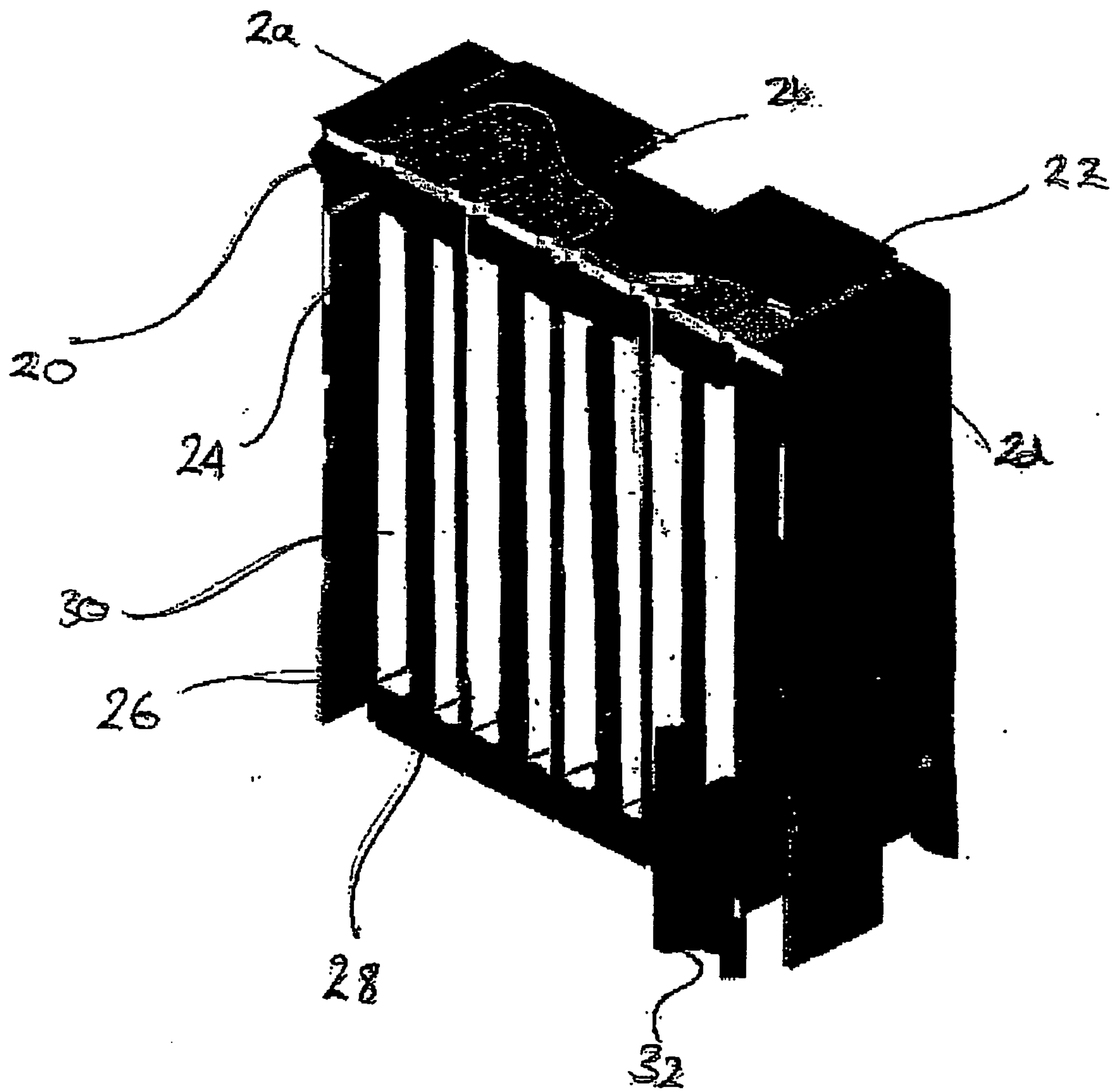


Figure 2

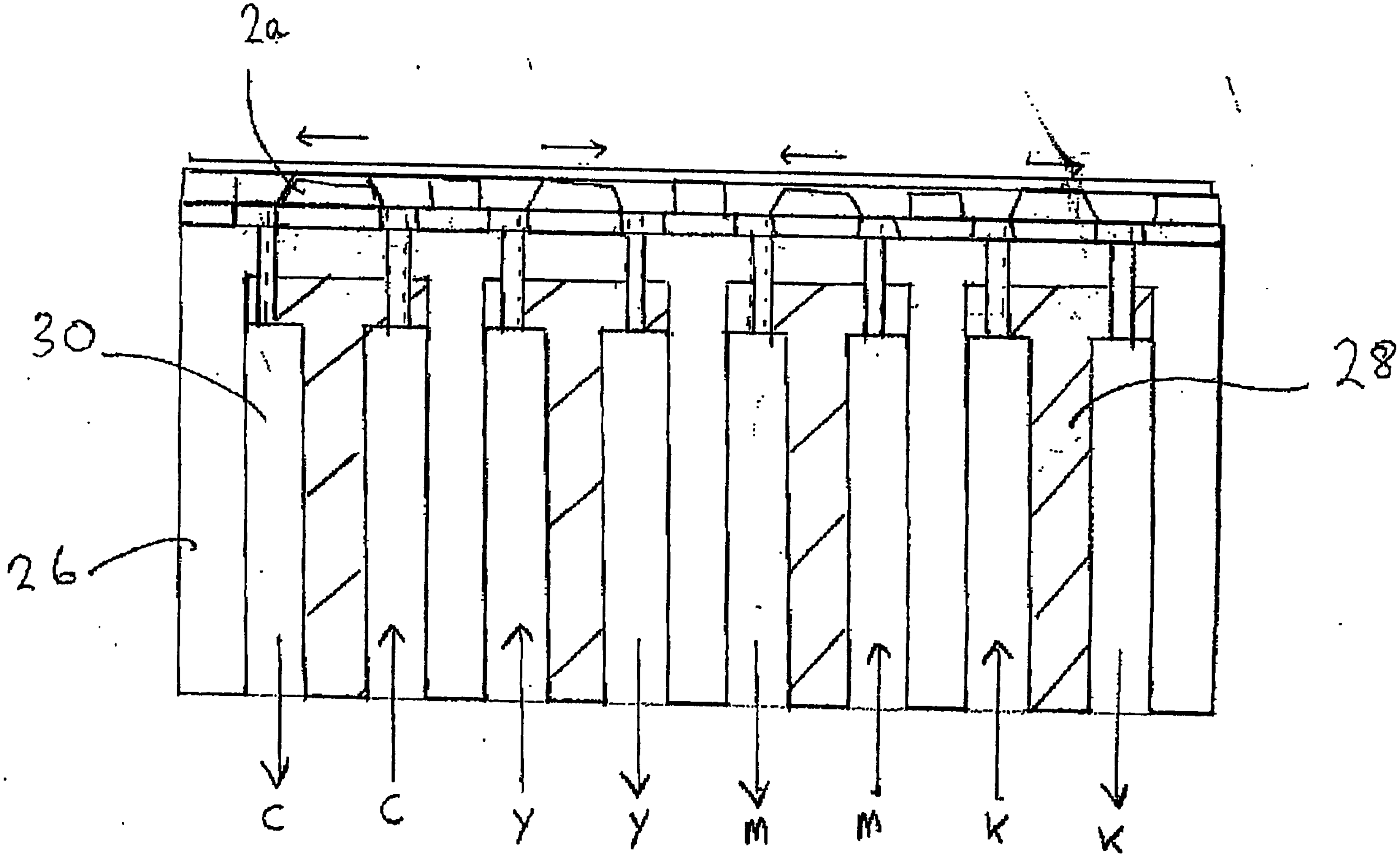


Figure 3

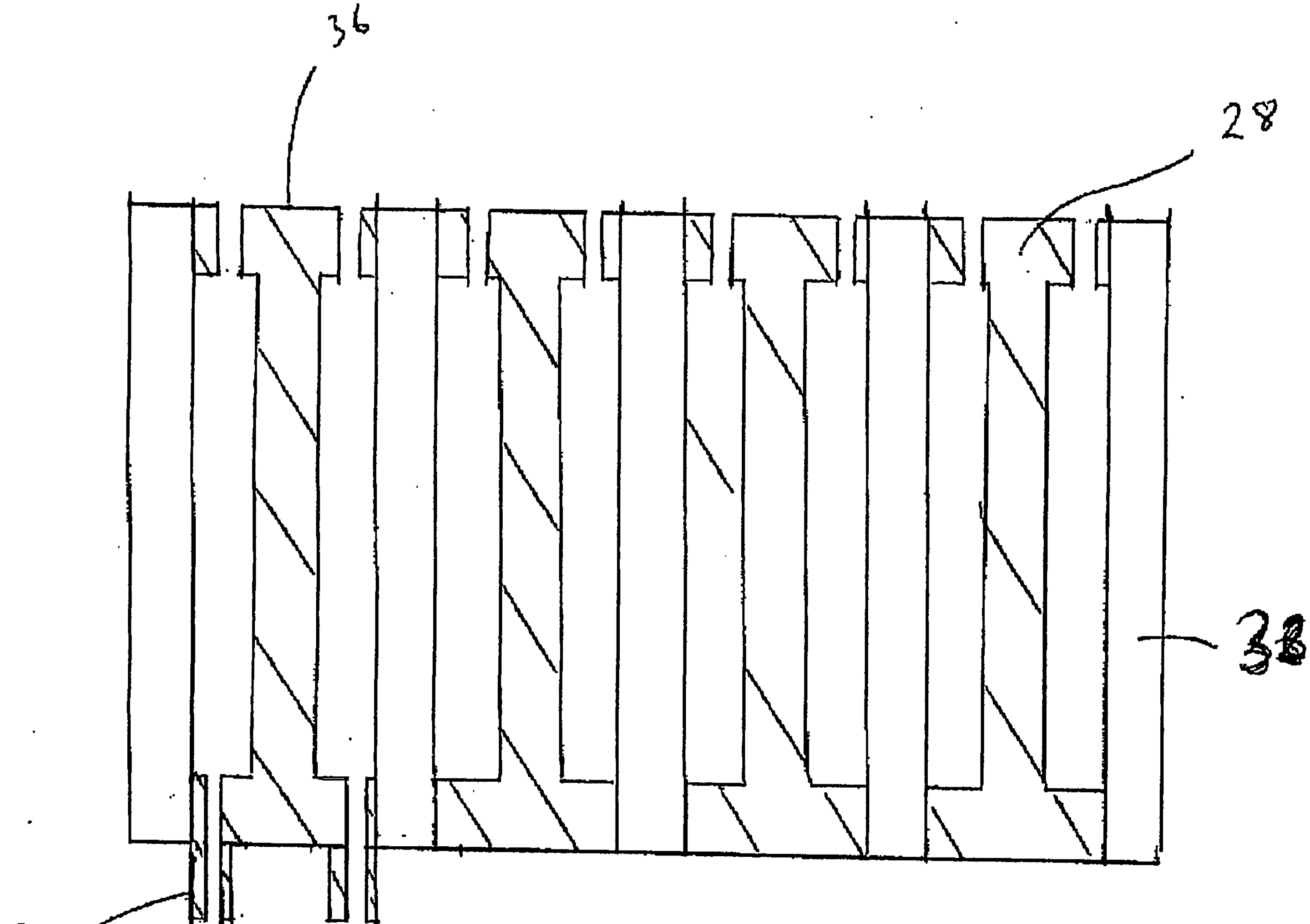


Figure 3a

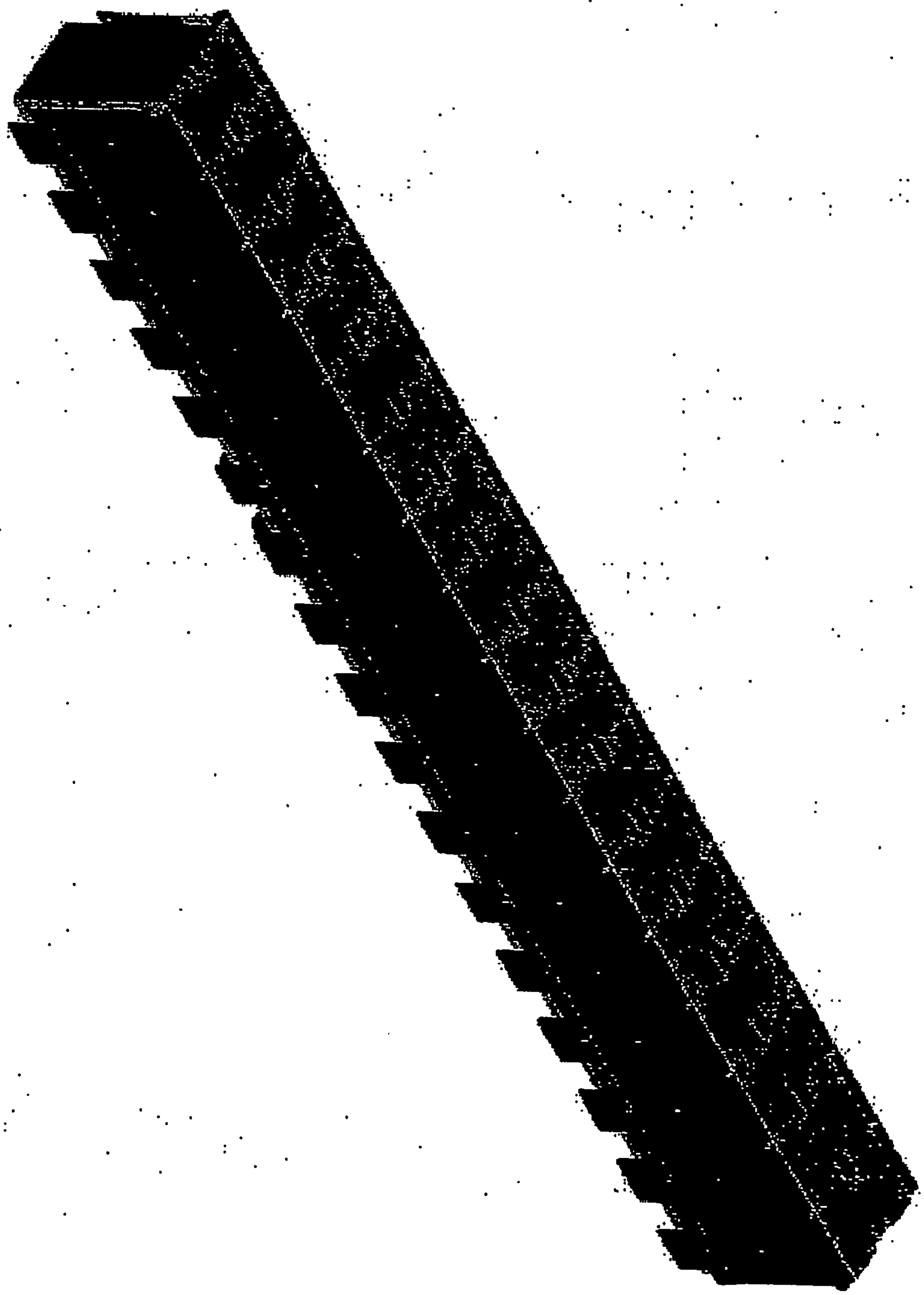


Figure 4

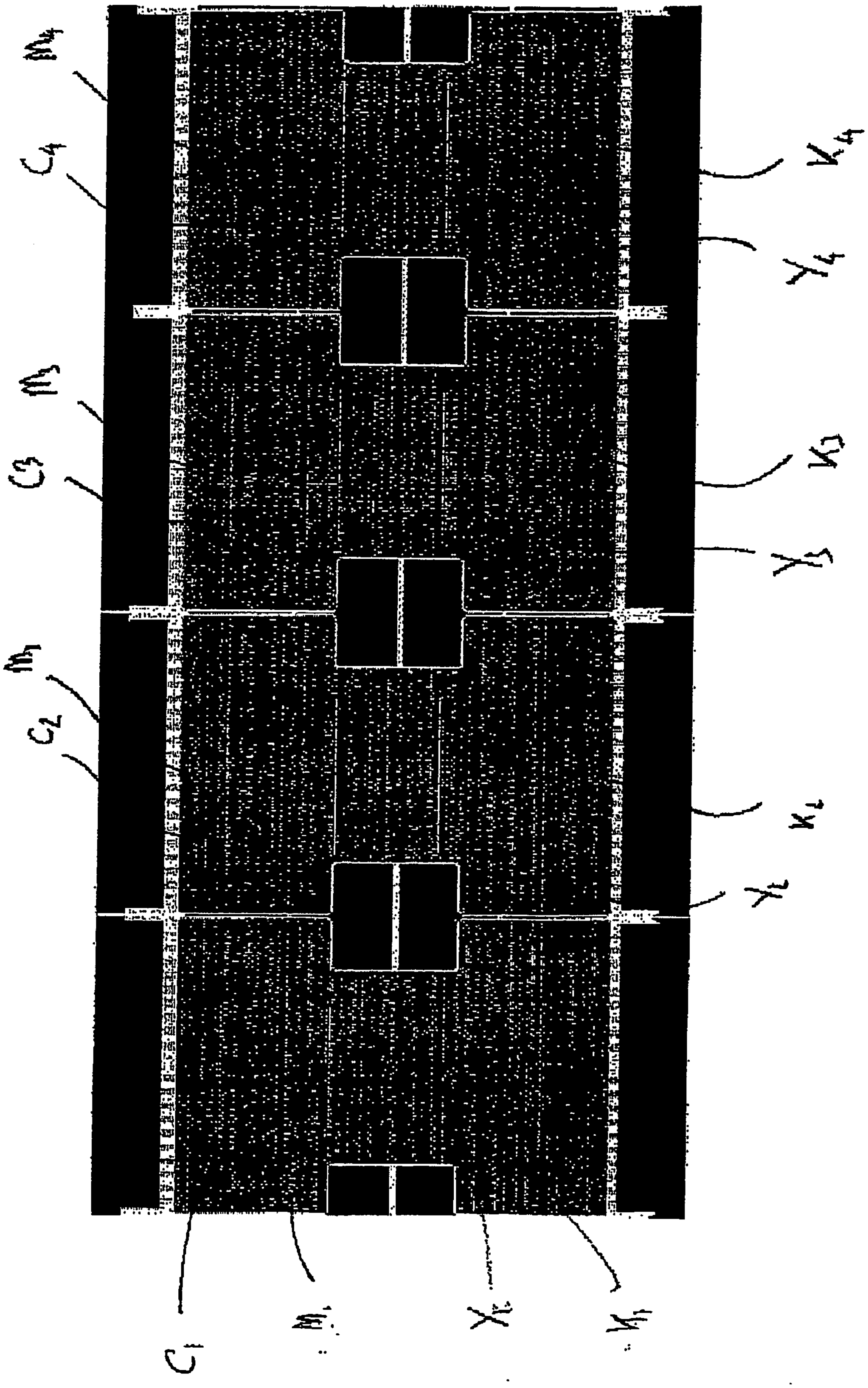


Figure 5

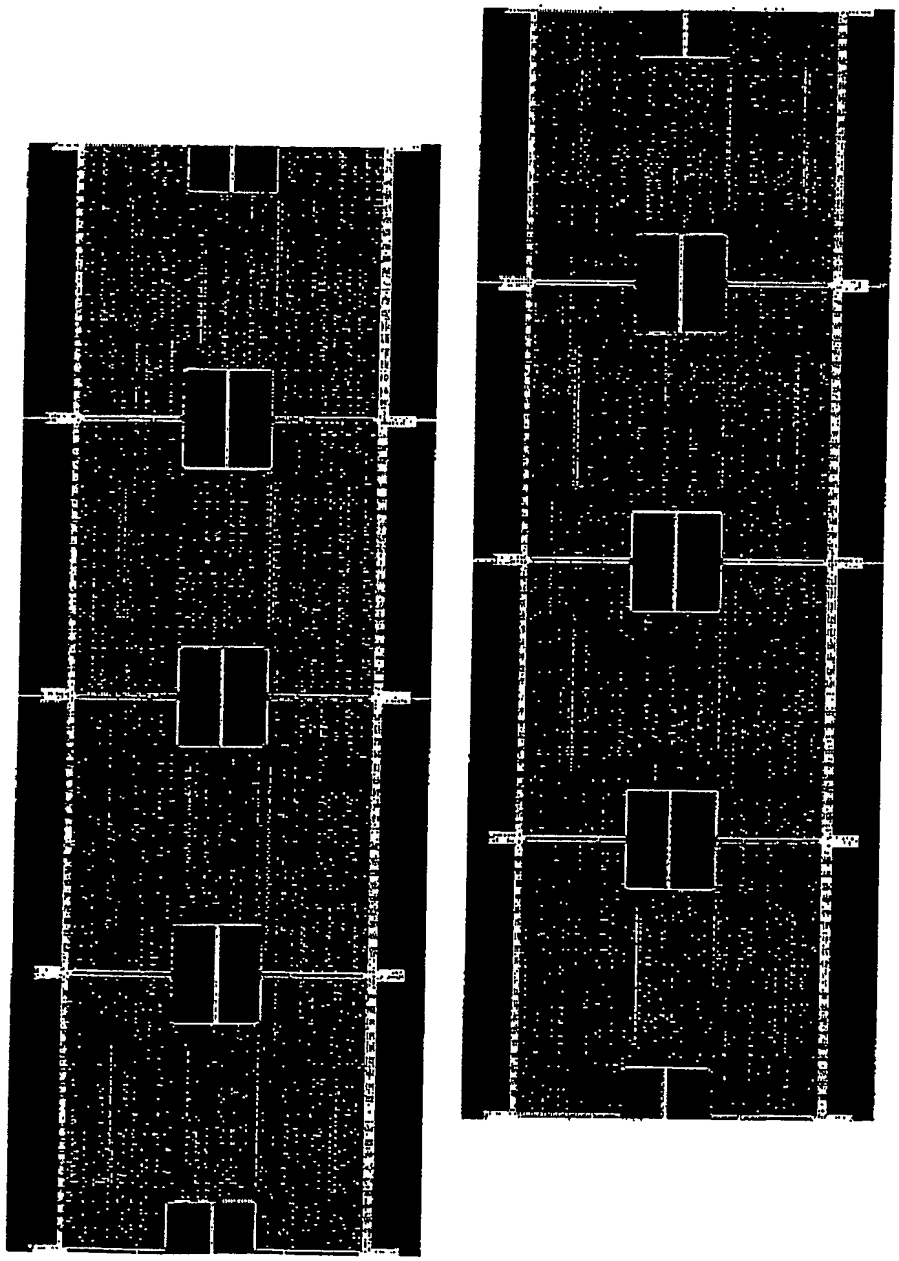


Figure 6

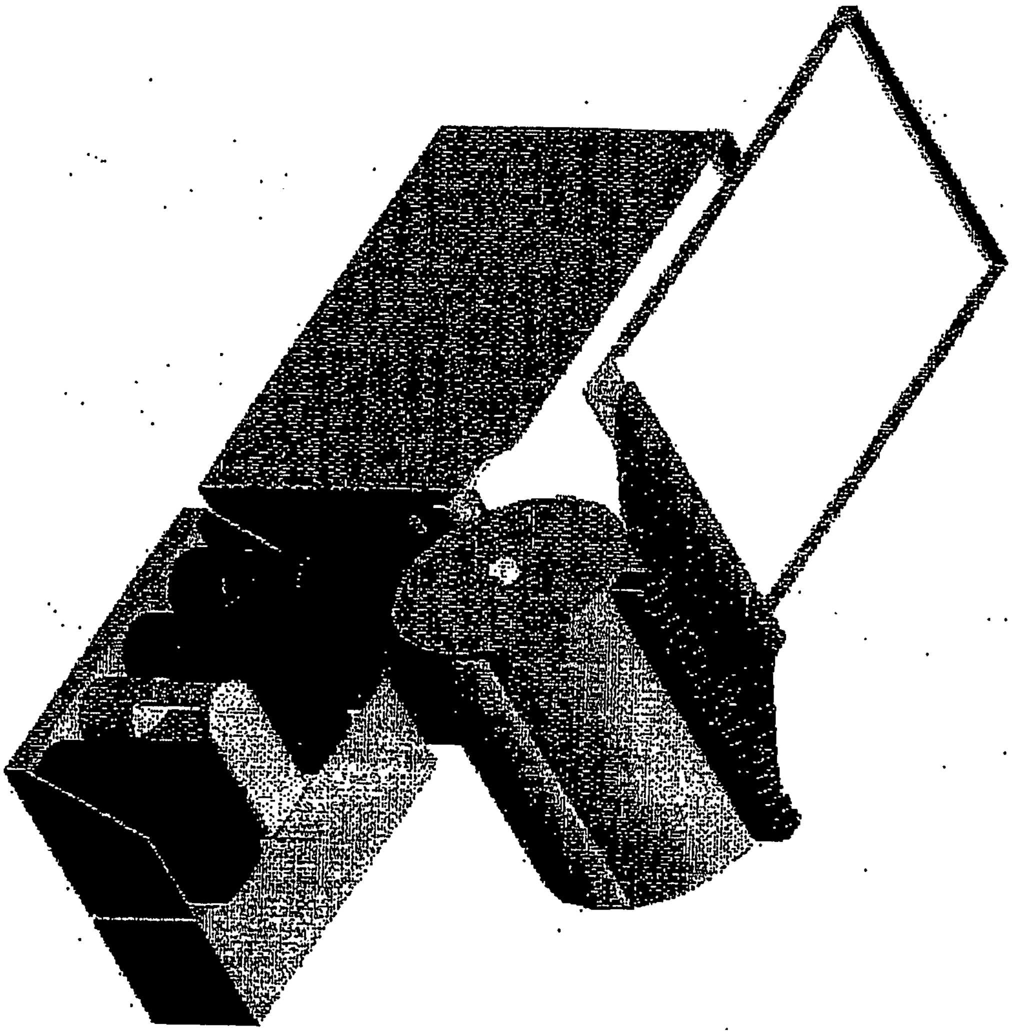


Figure 7

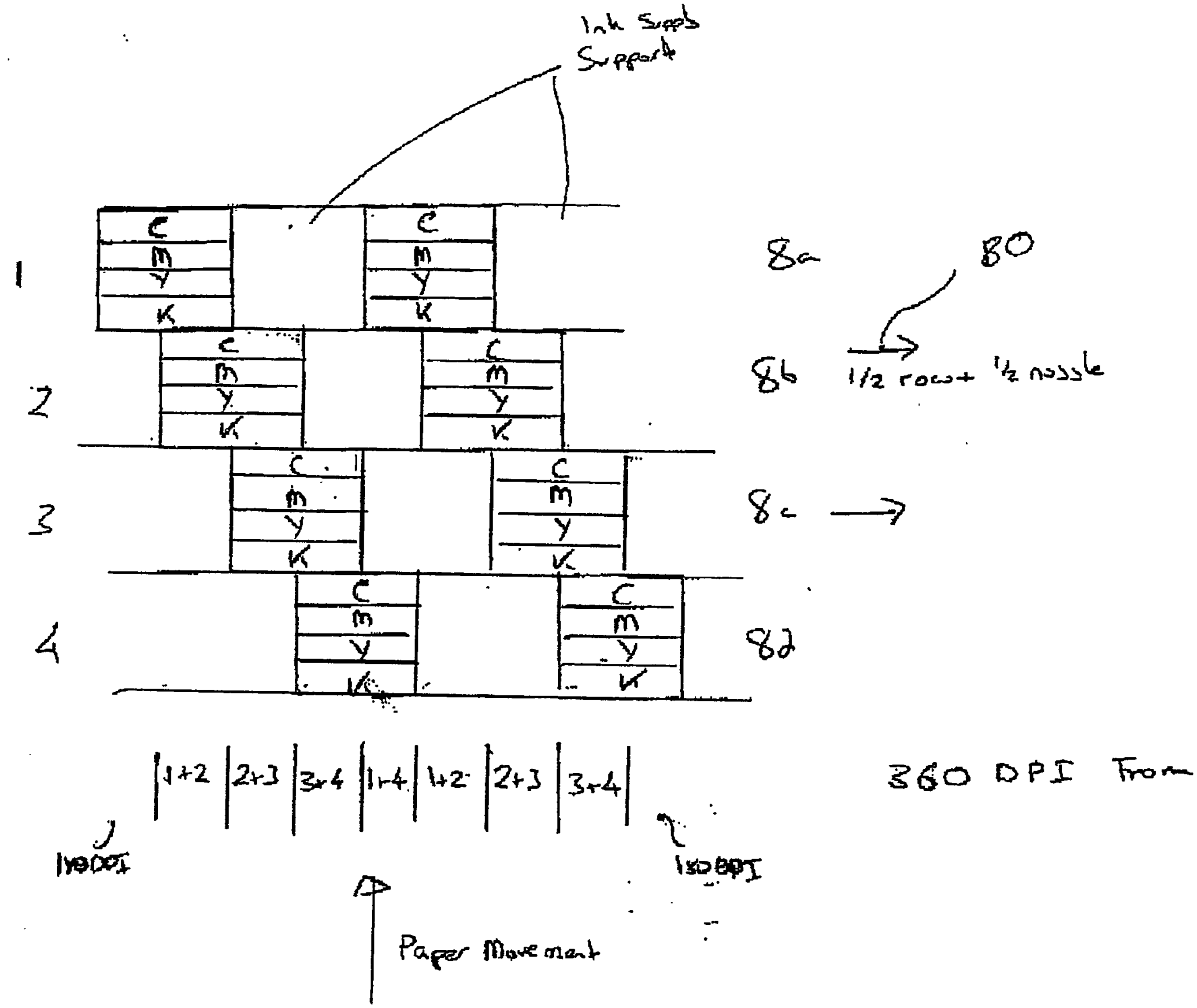

Ink Supply Support
C
M
Y
K
1
2
3
4
8a
80
8b
1/2 row + 1/2 nozzle
8c
8d
1+2
2+3
3+4
1+4
1+2
2+3
3+4
360 DPI From
180 DPI
180 DPI
Paper Movement

Figure 8

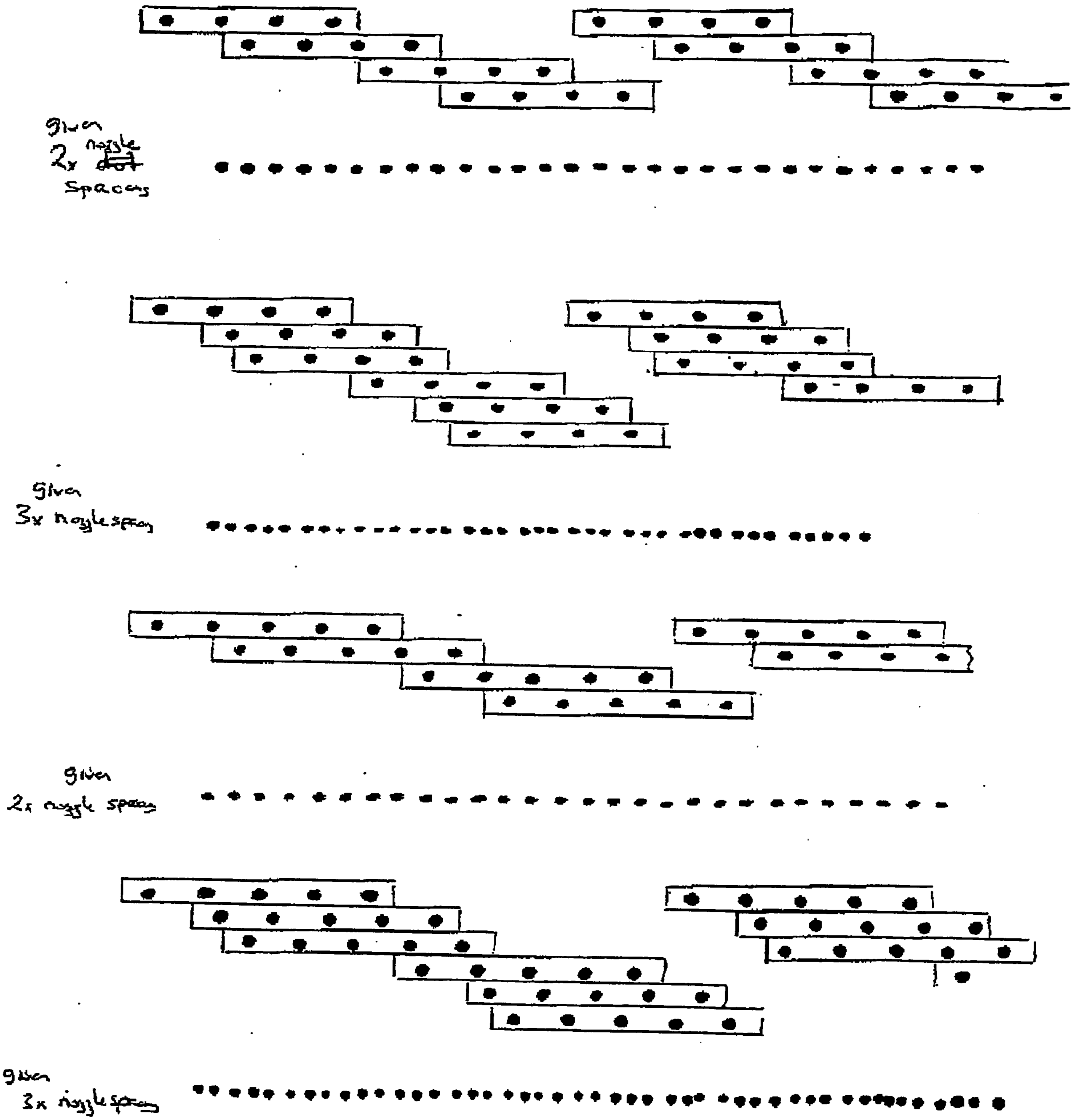

given 2x nozzle ~~dot~~ spacing
given 3x nozzle spacing
given 2x nozzle spacing
given 3x nozzle spacing

Figure 9

This Page is Inserted by IFW Indexing and Scanning Operations and is not part of the Official Record

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☐ BLACK BORDERS
- ☐ IMAGE CUT OFF AT TOP, BOTTOM OR SIDES
- ☐ FADED TEXT OR DRAWING
- ☐ BLURRED OR ILLEGIBLE TEXT OR DRAWING
- ☐ SKEWED/SLANTED IMAGES
- ☐ COLOR OR BLACK AND WHITE PHOTOGRAPHS
- ☐ GRAY SCALE DOCUMENTS
- ☑ LINES OR MARKS ON ORIGINAL DOCUMENT
- ☐ REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY
- ☐ OTHER: ______________________

IMAGES ARE BEST AVAILABLE COPY.
As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.